CLAIMS

What is claimed is:

1. A method, comprising:

applying a flux to a first surface of a substrate, the first surface of the substrate having attached thereto solder bumps, the solder bumps having a melting temperature, and the flux substantially comprising ingredients that have a volatilization temperature less than the melting temperature;

generally aligning the solder bumps with corresponding metal bumps, the metal bumps being attached to a first surface of a chip;

bringing the solder bumps into contact with the corresponding metal bumps; and

heating the solder bumps to a first temperature, the first temperature being equal to or greater than the melting temperature.

2. The method of claim 1, wherein the first surface of the chip comprises copper.

3. The method of claim 1, wherein the bringing of the solder bumps into contact with the corresponding metal bumps, further includes applying a contact force.

4. The method of claim 3, wherein the contact force is removed just after the solder bumps have been heated to at least the melting temperature.

5. The method of claim 1, wherein the solder bumps are comprised of a 96.5% tin, 3.5% silver solder.

6. The method of claim 1, wherein the flux includes a carboxylic acid and has a volatilization temperature of approximately 200 degrees Celsius.

7. The method of claim 1, further comprising:

joining the solder bumps to the metal bumps by cooling the solder bumps to a temperature below the melting temperature;

heating the first surfaces of the chip and substrate to within a temperature range, the temperature range being equal to or greater than the volatilization temperature but less than or equal to the melting temperature; and

maintaining the chip and substrate first surfaces within the temperature range for a first period of time.

8. The method of claim 1, wherein the heating of the solder bumps comprises heating the solder bumps through a second surface of the chip, the second surface of the chip being opposite the first surface of the chip.

9. The method of claim 8, wherein the heating of the solder bumps to a first temperature further includes rapidly increasing the temperature of the second surface to a second temperature, the second temperature being greater than the first temperature, wherein a temperature gradient is established through the chip from the second surface at the second temperature to the first surface of the chip at the first temperature.

10. The method of claim 8, wherein the heating of the solder bumps to the first temperature comprises providing a heater in contact with the second surface.

11. The method of claim 9, wherein a third temperature at a second substrate surface opposite the first substrate surface is significantly below the first temperature, when the first surface of the chip is at the first temperature.

12. The method of claim 9, further comprises maintaining the second surface at the second temperature for a period of time.

13. The method of claim 12, wherein the period of time is approximately 1 to 5 seconds.

14. An apparatus, comprising:

a substrate placed against a first fixture,

the substrate having deposited thereon a plurality of solder bumps and a flux, each of the plurality of solder bumps having a melting point at a first temperature, and the flux having a volatilization temperature at which substantially all of the constituents of the flux volatilize, the volatilization temperature being less than or equal to the first temperature,

the first fixture being maintained at a second temperature below the first temperature;

a chip placed against a second fixture,

the chip having affixed thereto a plurality of metal protrusions,

the second fixture coupled with a heater, the heater being maintained at a third temperature, the third temperature being less than the first temperature;

the plurality of solder bumps placed into contact with the plurality of metal protrusions by moving one or both of the first and second fixtures towards each other;

the heater having a temperature rapidly increased from a third temperature to a

fourth temperature, the fourth temperature being higher than the first temperature; and

a pulse heat tool held approximately at or above the fourth temperature until the plurality of solder bumps have melted and wetted the plurality of metal protrusions.

15. The apparatus of claim 14, wherein the substrate has deposited thereon the plurality of solder bumps, and the chip has affixed thereto a plurality of metal protrusions.

16. The apparatus of claim 14, wherein the second temperature is approximately within a range of 100 to 170 degrees Celsius.

17. The apparatus of claim 14, wherein the third temperature is approximately between 30 to 100 degrees Celsius, and the fourth temperature is approximately between 250 to 400 degrees Celsius.

18. The apparatus of claim 14, wherein the temperature is rapidly increased from the third to fourth temperature at a rate of 50 degrees Celsius per second or faster.

19. The apparatus of claim 14, wherein the plurality of solder bumps and the plurality of bump metal protrusions are placed in contact with each other by applying a contact force.

20. The apparatus of claim 19, wherein the contact force is removed once the plurality of solder bumps reach the first temperature.

21. The apparatus of claim 14, wherein the first and second fixtures and the heater comprise a thermo-compression bonder.

22. A system for interconnecting a chip and a substrate, comprising:

metal protrusions applied to electrical interconnect pads on an active surface of the chip, the chip also having second surface opposite the active surface;

solder bumps applied to electrical interconnect pads on a top surface of the substrate, the substrate also having a bottom surface, the solder bumps having a melting temperature;

the solder bumps coated with a no-clean flux, the no-clean flux comprised primarily of constituents having volatilization temperatures that are less than the melting temperature;

the bottom surface of the substrate placed on a platen of a thermo-compression bonder, the platen being maintained at a first temperature that is less than the volatilization and melting temperatures;

the second surface of the chip affixed to a head of the thermo-compression bonder, the head including a heater;

the solder bumps generally aligned with corresponding metal protrusions;

the head is lowered or the platen is raised to bring the solder bumps into contact with the metal protrusions;

a contact force applied to hold the solder bumps and corresponding metal protrusions together;

the heater having a temperature increased until the second surface of the substrate reaches a second temperature, the second temperature being greater than

the melting temperature; and

the second surface held at the second temperature for a period of time until the solder bumps have melted.

23 The system of claim 22, wherein the contact force is removed once the solder bumps begin to melt.

24. The system of claim 22, wherein the temperature of the heater is increased at a heat-up rate in excess of 30 degree Celsius a second.

25. The system of claim 22, wherein the heater is a pulse heat tool.

26. A method, comprising:

providing a chip, the chip having an active surface comprised of a plurality of chip pads;

providing a substrate, the substrate having a top surface comprised of a plurality of substrate pads corresponding to the plurality of chip pads;

applying a first plurality of solder bumps or a first plurality of metal bumps to the plurality of chip pads;

applying a second plurality of solder bumps or a second plurality of metal bumps to the plurality of substrate pads, wherein the corresponding pluralities of chip and substrate pads do not both have a plurality metal bumps attached thereto;

substantially covering the solder bumps with a no-clean flux, the no-clean flux substantially consisting of components having volatilization temperatures below a melting temperature;

generally aligning the plurality of chip pads and the plurality of substrate pads;

bringing the first plurality of solder bumps into contact with the second plurality of metal bumps, and applying a contact force; and

heating the first plurality of solder bumps to a first temperature in excess of the melting temperature.

27. The method of claim 26, wherein the first plurality of metal bumps are applied to the plurality of chip pads, and the second plurality of solder bumps are applied to the plurality of substrate pads.

28. The method of claim 26, wherein the first plurality of solder bumps are applied to the plurality of chip pads, and the second plurality of solder bumps are applied to the plurality of substrate pads.

29. The method of claim 26, wherein the first plurality of solder bumps are applied to the plurality of chip pads, and the second plurality of metal bumps are applied to the plurality of substrate pads.

30. The method of claim 26, further comprises heating the first plurality of solder bumps to the melting temperature at a rate in excess of 50 degrees Celsius per second.

31. The method of claim 26, further comprises heating the second plurality of solder bumps to the melting temperature at a rate in excess of 50 degrees Celsius per second.

32. An apparatus, comprising:

a first surface of a substrate, the first surface of the substrate having attached thereto solder bumps, the solder bumps having a melting temperature;

a flux applied to the first surface of the substrate, the flux substantially comprising ingredients that have a volatilization temperature less than the melting temperature; and

metal bumps having aligned with the solder bumps, bringing the solder bumps into contact with the corresponding metal bumps.

33. The apparatus of claim 32, further comprises a first surface of a chip, wherein the metal bumps being attached to the first surface of the chip.

34. The apparatus of claim 33, wherein the first surface of the chip comprises copper.

35. The apparatus of claim 32, wherein the solder bumps are heated to a first temperature, the first temperature being equal to or greater than the melting temperature.

36. A system, comprising:

a first surface of a substrate, the first surface of the substrate having attached thereto solder bumps, the solder bumps having a melting temperature;

a flux applied to the first surface of the substrate, the flux substantially comprising ingredients that have a volatilization temperature less than the melting temperature;

metal bumps having aligned with the solder bumps, bringing the solder bumps into contact with the corresponding metal bumps; and

a first surface of a chip, wherein the metal bumps being attached to the first surface of the chip.

37. The system of claim 36, wherein the solder bumps are heated to a first temperature, the first temperature being equal to or greater than the melting temperature.

38. The system of claim 36, wherein the solder bumps are comprised of a 96.5% tin, 3.5% silver solder.

39. The system of claim 36, wherein the flux comprises a carboxylic acid and has a volatilization temperature of approximately 200 degrees Celsius.